The Impact of the Minimum Wage on Unemployment

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Abstract:

Classical microeconomic theory consistently suggest that through modelling the labor market in a supply and demand point of view, the minimum wage acts as a binding price floor that if set above the "equilibrium" wage could manifest in a labor surplus, otherwise known as unemployment. This cross-sectional study uses state-level data to determine if there is a statistically significant relationship between the minimum wage and the unemployment rate. The study also controls for educational attainment, population growth, GDP growth, per capita GDP growth, state share of urban population, and changes in the per capita personal consumer expenditure. The results of the study show that the initial hypothesis that agrees with microeconomic theory is not supported by the data. Alternatively, educational attainment rates and the per capita state GDP emerge as more reflective indicators of the unemployment rate.

I. Introduction

The minimum wage is the lowest hourly wage that an employee may be compensated by a company (whether public or private) for their labor. The wage was originally established by the Fair Labor Standards Act with the purpose of protecting workers during post-depression America. Since then, the minimum wage has had many different roles and economic intentions highlighted including being a protection for entry level workers, a safeguard for workers that may lack negotiation power, and a mechanism to remedy income inequality in America. These numerous interpretations of the primary role of the minimum wage have generated political debate. Despite the political implications of the minimum wage, it certainly offers an indication of the economic well-being of low or unskilled workers.

As an easily controllable economic regulation, the minimum wage can be measured as an explanatory variable as to verify its correlation with other indicators of economic well-being. One major example of said potentially correlated indicators is the unemployment rate. The minimum wage may be modelled as a government mandated price floor on the price of labor. In typical microeconomic theory, if this minimum wage were to exceed the natural wage that would result from market interactions with laborers as the supplier and employers as the consumer, it would result in a labor surplus. This surplus would simply manifest as a higher unemployment rate. As such, the relationship between the minimum wage and the unemployment rate is of high importance when considering the economic consequences of raising, lowering, or maintaining the minimum wage.

When considering the microeconomic rationale from above, one must take note that this analysis is not a completely multivariate view of the effects of increased capital costs on business, as it implies that a business would not naturally seek out other mechanisms by which to distribute the increased cost of production. Examples of alternative routes that would not necessarily lead to unemployment include increase cost of goods, technological investment, and decreased administration cost.

Regardless of these other effects of the minimum wage, this paper will explore the potential correlation between the minimum wage and the unemployment rate using a simple regression model analyzing cross-sectional data of the state-based minimum wages and corresponding unemployment rates. In addition, the paper will explore the possible influence of other economic variables on this relationship through multiple linear regression. In agreement with the microeconomic theory previously described, the hypothesis is that the minimum wage and the unemployment rate will be positively correlated. This is under the presumption that increasing the wages that a business must pay may cause small businesses to be unable to continue operation when subjected to increased cost of lower-skilled human capital.

II. Literature Review

Waltman, McBride, and Camhout (1998) analyzed the hypothesis of whether business failure rates increased in the years of and years directly proceeding a minimum wage increase in America. In addition, the authors also analyzed the effect of the magnitude of the increase to the minimum wage. This was done using business failure rate and minimum wage data from 1949 to 1983. To carry out this analysis, the authors compared the mean failure rate (per 10,000 businesses) of the years of minimum wage increases with all other years, to which they calculated mean failure rates of 43.2 and 50, respectively. The authors then compared the mean failures rates of years directly proceeding a minimum wage increase and all other years, which resulted in means of 48.4 and 47.6, respectively. While the first set of mean failure rates seems to imply that minimum wage increases does not correlate to more businesses failing (in fact, the contrary is implied by the relatively large difference between the means), the second set of means illustrates a marginal increase in the years proceeding minimum wage increases compared to all other years. The second set is perhaps a bit more revealing of the actual effect, as economic policy changes typically do not cause an immediately tangible effect, meaning that the proceeding years would echo the effects more clearly than the years of the increases. However, the study also regressed the business failure rates on the magnitude of minimum wage increases in both the years of and directly proceeding. From this regression, the authors discovered a negative correlation in both regressions, meaning that, according to the data set, when the minimum wage increase was greater in magnitude, the business failure rate was lower. This study clearly contradicts the microeconomic model of the projected effect of a minimum wage increase through a longitudinal study. However, given the differing economic climates that America experienced in that 34-year period, further analysis may be required to uncover a true ceteris paribus effect. In addition, this study utilizes the business failure rate an indication of potential unemployment rate, however, differing business sizes and scope can potentially skew the translation of a business failure rate to state-based unemployment rates.

A journal published by Chuang (2006) explores the effect of increasing the Taiwanese minimum wage on the employment and participation rates of youths (defined as the sector of the population between the ages of 15 to 19). The format of this regression helps isolate the effects on the teen employment rate from increased participation rates versus the increase to the minimum wage, which helps draw more interpretations of the short-term and long-term economic benefits and downfalls of periodic increases to the minimum wage. The model adopts 128 observations representing time-series quarterly data from 1973 to 2004. The overall change in the youth participation rate in the labor market was a decrease from 50% to 11% while the total share of the population that was classified as youth dropped from 21.2% to 8.8%. The unemployment rate exhibited an increase from 2.4% to 12%, which is consistent with the population and participation rate decreases. However, the author asserts that this decrease in employment is due to growth in industrial-based labor market structures, which would incentivize increased school participation rates. After running the regression, the author presents that a 10% increase to the minimum wage results in a 0.47% increase to the youth employment rate, with the slope parameter being significant after accounting for time trend and seasonal dummies. To further isolate the effects of population growth, the regression model also suggests that a 1% increase to the youth population results in a 1.83% increase to the youth employment rate. Next, the author defines a relationship between the youth participation rate and the minimum wage by showing that the model depicts a 10% increase in the minimum wage results in a 0.47% increase to the youth participation rate in the labor market. These results, which show positive and statistically significant coefficients for the minimum wage, suggests that increases to the minimum wage have marginally positive effects on both the employment and participation rates of youth (which are coincidentally the same percentage effect).

Nissen (2007) conducted a short study comparing the effects on unemployment in Florida after the Florida legislature increased the minimum wage twice. As a control metric, the author compared the progression of Florida's unemployment rate to the national average. It must be noted that although Florida already had a much lower unemployment rate than the nation, the post-increased minimum wage time-period did not display any discernible increases to the unemployment rate. As such, the author asserts that despite classical economic theory regarding supply and demand, the descriptive statistics associated with unemployment did not depict a negative impact from increasing the minimum wage. In fact, the only easily recognizable short-term effect of the minimum wage increase was a decrease in the working population that was classified as earning a "very low wage", which was defined as jobs paying well below the national average. Therefore, the decrease to this statistic implies a positive effect to the competitive advantage of Florida over other states. Additionally, it was found that Florida's job growth rate was higher than the national average after raising the minimum wage, but a causal relationship is not claimed.

Card and Krueger (1993) carried out an in-depth survey-based study on fast-food restaurants in New Jersey, where the minimum wage had increased from $4.25 to $5.05. The authors established the fast-food counterpart restaurants in neighboring state Pennsylvania as the control group, as the similar geographic and economic factors were projected to be like those of New Jersey. In this study, the New Jersey fast-food restaurants were split into three groups based on their initial wages before the minimum wage increase, whether exactly the previous minimum wage ($4.25), between $4.26 and $4.99, or $5.00 and above. The first metric presented was the difference in employment growth rates before and after the minimum wage increase between the New Jersey restaurants in their Pennsylvania counterparts. When the differences across all the initial wage groups was averaged, it was found that the New Jersey restaurants grew at a rate 13% greater than those in Pennsylvania (there was a nominal difference of growth rates before and after the minimum wage increase of 2.76%). Next, the authors compared the employment rate changes in the low-wage versus the high-wage restaurants. After the minimum wage increase, the employment rate grew for low-wage restaurants while it contracted for the high wage restaurants. Given that the growth rates of employment were very similar between the high-wage restaurants in New Jersey and the Pennsylvania restaurants, the authors concluded that this employment contraction was not likely an effect of the increased minimum wage. Overall, this study was one of the first to challenge the conventional and theoretical notion of binding minimum wage increases having an adverse effect on employment rates for low-skill industries.

Although the previously mentioned studies account for many other controlled variables, the methodology used is time-series in nature. While still being able to reveal effects of changes to the minimum wage, varying economic conditions in different points in time are not controlled for, and therefore, except for the study conducted by Chuang (2006), economic upturns or downturns could skew the results and make it more difficult to unveil the ceteris paribus effect of minimum wage changes. However, the studies mentioned typically analyze a single region or state over time, which increases variability in the independent variable of minimum wage, which subsequently decreases the standard deviation of the slope parameters found in the respective regression models. By utilizing a cross-sectional data set that analyzes the minimum wage and unemployment rates across different states at a single point in time, the effect of national economic conditions and turbulences can be controlled while accepting the tradeoff of decreasing the variability in minimum wage values leading to a slope parameter associated with minimum wage that has a greater standard deviation.

III. Data

Unlike much of the previously published literature regarding the relationship between the minimum wage and unemployment, this study utilizes exclusively cross-sectional data gathered on each of the 50 states and the District of Columbia. Most data gathered is with respect to 2019, which was meant to avoid any potential effects of the COVID-19 global pandemic on unemployment rates and many of the independent variables used in the multiple regression analysis. The exceptions include the educational attainment data from 2018, the per capita personal consumer expenditure from 2018, and the percentage of state population living in urban areas from 2010. The primary dependent variable used is the unemployment rate by state (unemploy), which was collected from the Bureau of Labor Statistics. The primary independent variable for which the paper seeks the ceteris paribus effect is the minimum wage by state (minWAGE), which was collected from the U.S. Department of Labor. The data on the state minimum wages can be depicted as two groups: those with a minimum wage above the national one or those with a minimum wage equal to the national one. It is worth noting that many states have legal minimum wages set below the national minimum wage, but because it is rare for an employee to not be covered by the Fair Labor Standards Act, any state exhibiting such a minimum wage is automatically considered to have a minimum wage equal to the national one. The state-level data was selected to reduce any variability from economic conditions that would otherwise appear in time series data. However, the variability in the primary independent variable is less than the time series counterpart, meaning the standard error of the estimated slope parameter may be greater. An initial scatter plot with fitted values of the unemployment on the y-axis and the minimum wage on the x-axis is shown in Figure 1.

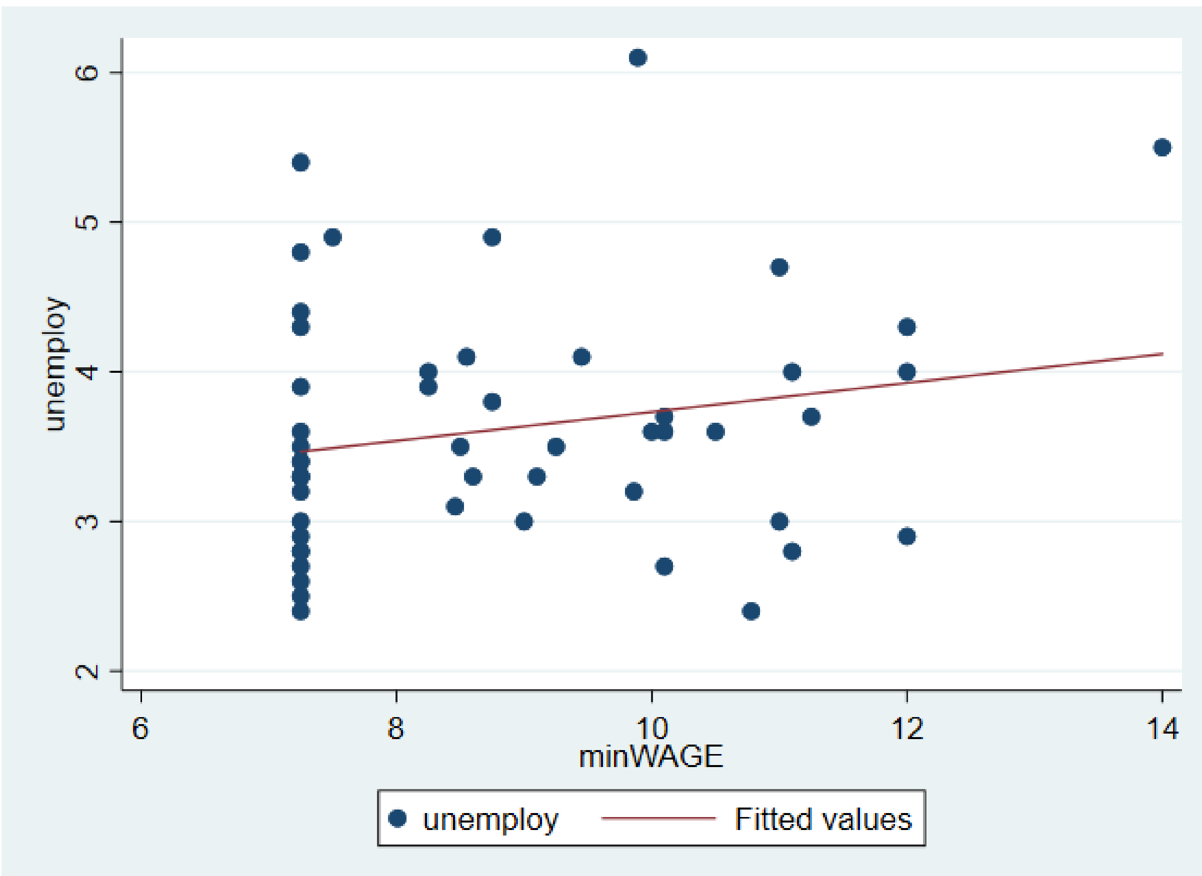

Figure 1. Scatter Plot of State Unemployment Rate versus State Minimum Wage with Fitted Values

From this scatter plot and corresponding fitted values, a mild positive correlation can be seen. However, there is a multitude of data points with a minimum wage value equal to $7.25. This expresses that many of the states have minimum wage laws that set the wage below or exactly equal to the national minimum wage. Many of these data points at the $7.25 minimum wage are concentrated at lower levels of unemployment. As previously discussed, this unfortunately decreases the variability of the primary independent variable, but is the tradeoff taken in this study to utilize solely cross-sectional data to reduce effects of different economic conditions that would otherwise be present in a time-series study. However, there are two notable outliers in the data set. One lies at a minimum wage of just under $10 but is associated with an unemployment rate of over 6%. Given that none of the other data points are remotely close to an unemployment rate of 6%, it may be presumed that this rate arises from unobserved factors or economic turbulences. The second major outlier is the data point with a minimum wage of $14 and unemployment rate of approximately 5.5%, which is much higher than the other data points that also have relatively high magnitude minimum wages.

In addition to the minimum wage, the data set includes other independent variables that are controlled for in the multiple regression analysis. This will help to find a more accurate ceteris paribus effect of the minimum wage on the unemployment rate. The additional controlled independent variables are the natural logarithm of state population (logpop), natural logarithm of state GDP (logstGDP), education attainment percentage for people in the state over the age of 18 (educ), the natural logarithm of the per capita state GDP (logcapGDP), the percentage change in per capita personal consumer expenditure from 2018 to 2019 (capPDE), and the percentage of the state population residing in urban populations (urbpop). The population data was collected from the United States Census Bureau, the state GDP data was collected from U.S. Bureau of Economic Analysis, the educational attainment data was collected from the National Center of Education Statistics, the per capita state GDP data was collected from the Statista Research Department, the urban population data was collected from Iowa State University, and the personal consumer expenditure data was collected from the U.S. Bureau of Economic Analysis. The state population must be controlled for as states with very high population (such as California, New York, or Florida) may be more susceptible to unemployment as there is naturally a more competitive human capital market. Therefore, the coefficient associated with population is predicted to be positive. The state GDP is measured in billions of USD and is predicted to have an associated coefficient that is negative, meaning the higher the state GDP, the lower the unemployment rate will be. This stems from the fact that GDP is often used as an economic measure of the producer productivity in a region (in this case, states). Greater productivity would mean that there are more jobs being filled and, therefore, unemployment would be minimized. The reasoning for state GDP carries over to the prediction of the slope parameter for per capita state GDP, which is then similarly predicted to have a negative coefficient. The educational attainment data used is measured as a percentage of the population above the age of 18 who have at least a high school education (or equivalent). This independent variable is predicted to have a negative coefficient, as a population that is more educated has more valuable human capital and is more likely to be employed. The percentage change in per capita personal consumer expenditure is included to control for inflation and is predicted to have a negative slope parameter. Although the producer or consumer price indices would have been more representative of inflation, the unavailability of state-level data required use of the personal consumer expenditure. Increases to inflation potentially mean there is more money supply available for firms to hire more employees, therefore the coefficient is predicted to be negative. Lastly, the percentage of the state population residing in urban areas is used as a measure of urbanization for a state and is predicted to have a positive coefficient, as urban areas typically struggle with homeless and otherwise unemployed populations. Table 1 summarizes the primary dependent, primary independent, and additional controlled independent variables below.

Table 1. Variable Summary

Variable	Description	Year	Units	Source
unemploy	State unemployment rate	2019	Percentage of population	U.S. Department of Labor
minWAGE	State minimum wage	2019	U.S. Dollars	U.S. Department of Labor
logpop	Natural logarithm of total state population	2019	Constant millions of people	United States Census Bureau
logstGDP	Natural logarithm of state gross domestic product	2019	Constant billions of USD	U.S. Bureau of Economic Analysis
educ	Educational attainment rate of state population above the age of 18 with at least high school education (or equivalent)	2018	Percentage of state population	National Center for Education Statistics
urbpop	Percentage of state population living in urban areas	2010	Percentage of state population	Iowa State University
logcapGDP	Natural logarithm of the state GDP per capita	2019	Constant USD	Statista Research Department
capPCE	Per capita personal consumer expenditure for state from 2018 to 2019	2018	Percentage change	U.S. Bureau of Economic Analysis

To initiate the analysis of these variables, the descriptive statistics are listed in Table 2 below:

Table 2. Descriptive Statistics of Variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
unemploy	51	3.62	0.82	2.4	6.1
minWAGE	51	8.85	1.75	7.25	14
logpop	51	1.36	1.04	-0.55	3.68
logstGDP	51	5.48	1.06	3.55	8.05
educ	51	89.82	2.6	83.9	94
urbpop	51	74.12	14.89	38.7	100
logcapGDP	51	10.91	0.25	10.46	12.09
capPCE	51	3.05	0.68	1.8	5

Before creating any regression models, the Classical Linear Model Assumptions must be discussed and met. The following list describes how these assumptions apply to the data used in this study:

1. **Linearity of Parameters such that:** $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + u$
   Where β_1 , β_2 , and β_k are the slope parameters that describe the relationship between the respective independent variables and the dependent variable in the population. The u is the error term representing all unobserved and uncontrolled disturbance in the data in the population. The regression models generated in this study are all linear in parameter, so the first assumption is satisfied.
2. **Data collected from random sample:** Since the data collected is from each of the fifty states of the U.S. and the District of Columbia, this assumption is satisfied by nature of the data not being selected from only particular states.
3. **No perfect collinearity:** None of the independent variables used in the study are constant values, meaning they all have sample variation (although minWAGE has less variation than the other independent variables used due to so many states having minimum wages equal to the national one). STATA was used to ensure no perfect correlations between any of the independent variables, which is depicted in Appendix B. However, the logcapGDP is a linear combination (specifically, the difference) of logstGDP (in USD) and logpop (in people). Due to logcapGDP violating multicollinearity, it will not be used in any models that use logpop or logstGDP.
4. **Zero Conditional Mean:** The error term *u* must have an expected value of zero given any values of the independent variables. Given the interconnectedness of factors that all may affect unemployment rates, there is a possibility that the independent variables used contain information about the unobserved factors contained in *u* that may affect the dependent variable. This

assumption may not be completely satisfied. Establishing that the independent variables used may be endogenous, the results are interpreted with caution.

5. **Homoskedasticity:** The error term *u* must have a constant variance given any values of the independent variables. As previously discussed in assumption four, the independent variables may be endogenous, and therefore, it is difficult to assume that they do not affect the variance of the error term. Results are subsequently interpreted with caution.
6. **Normality of Error:** As assumptions 4 and 5 are not completely met, the study cannot verify if the error term *u* follows a normal distribution. As such, the analysis is carried out as intended and interpreted with caution.

IV. Results

The following regression models are generated to test the initial hypothesized relationship between the unemployment rate and minimum wage. Model 1 is a simple linear regression model excluding the additional explanatory variables. Model 2 is a multiple linear regression model including all the explanatory variables except logcapGDP, which can be done since all variables have 51 observations. In this section, the estimated parameters are generated, interpreted, and compared to the predicted relationships from the previous section. Interpretations, however, are made with caution considering that the CLM Assumptions 4, 5, and 6 may not be perfectly satisfied. Each model has both its population modelled equation and the corresponding OLS regression (sample regression function) presented.

<u>Model 1:</u>

The following model is a simple linear regression meant to find the relationship between the state unemployment rate and state minimum wage without controlling for other explanatory variables. All other factors are contained within the disturbance term *u* such that:

$$\textbf{Model 1: } \textit{unemploy} = \beta_0 + \beta_1(\textit{minWAGE}) + u$$

A total of 51 observations (each of the 50 states plus the District of Columbia) were used to generate the estimators of the sample regression function below:

$$\textbf{OLS Regression 1: } \textit{unemploy} = 2.766 + 0.097(\textit{minWAGE})$$

The level-level OLS model presented above suggest that a $1 increase to the minimum wage results in a 0.097 increase to the unemployment rate as a percentage of the population. The slope parameter is positive, which is consistent with the hypothesized relationship, however, the R-squared value is 0.0424. Therefore, of the total variation in the unemployment rate, only a small portion may be due to the variation of the minimum wage.

The intercept parameter simply suggests that a minimum wage of $0 results in an unemployment rate of 2.77%, however, since the states cannot legally enact a minimum wage below $7.25, the intercept is of very limited value to the analysis. Rather, it would be more useful to analyze the predicted unemployment rate at the lowest legal minimum wage of $7.25, which is 3.47%. This value is 44% greater than the minimum value of the data set, which may suggest that the model overestimates the effect of the minimum wage at lower dollar values of the wage. This is likely due to the significantly lesser variability of the explanatory variable at the lower end of the range, where there is a heavy concentration of data points at a $7.25 minimum wage. Additionally, the coefficient on minWAGE is only statistically significant at the 10% significance level when considering a one-sided t-test against the alternate hypothesis that the coefficient is greater than zero. The coefficient also has a p-value of 0.147, which clearly depicts its poor statistical significance at any major significance level for a two-sided test.

Given the relatively low correlation coefficient of the simple linear regression model, Model 1 may hint towards the relationship between the minimum wage and the unemployment rate, but further analysis using more controlled explanatory variables must be used to verify the potentially positive and linear relationship between the unemployment rate and the minimum wage.

<u>Model 2:</u>

The second model is a multiple linear regression that includes the rest of the explanatory variables with the intention of increasing the correlation coefficient and further isolating the effect of the minimum wage on the unemployment rate, which should translate to a more accurate slope parameter associated with minWAGE. Such a relationship is described in the model below:

$$\textbf{Model 2: } unemploy = \beta_0 + \beta_1(minWAGE) + \beta_2(\log pop) + \beta_3(\log stGDP) + \beta_4(educ) + \beta_5(urbpop) + \beta_6(capPCE)$$

The 51 data points collected resulted in the OLS estimators used in the sample regression function:

$$\textbf{OLS Regression 2: } unemploy = 15.625 + 0.086(minWAGE) - 0.92(\log pop) + 0.744(logstGDP) - 0.172(educ) - 0.005(urbpop) + 0.064(capPCE)$$

The R-squared value of this multiple regression model is 0.2347, which is significantly higher than that of the simple linear regression used in Model 1. The stronger correlation offers much more reassurance of the results since over a fifth of the total variation in the dependent variable can be explained by the explanatory variables used. Model 2 also results in a slightly lesser coefficient of minimum wage, which is 11% less than its Model 1 counterpart. As hypothesized, the coefficient is still positive, but indicates a weaker linear relationship between the minimum wage and the unemployment rate.

Using the level-level interpretation, the model suggests that a $1 increase to the minimum wage will result in approximately a 0.086 increase to the unemployment rate as a percentage when holding the logarithm of state population, logarithm of state GDP, educational attainment rate, percentage of population in urban areas, and change in per capita personal consumer expenditure constant. The intercept parameter offers little analytical value since most of the explanatory variables cannot possibility take on a value of 0.

As for the added controlled explanatory variables, only educational attainment has a coefficient that is consistent with the prior predictions. The coefficient of the logarithm of state population is negative; this suggests that a 10% positive change to the state's population results in a 0.092 decrease to the unemployment rate, when holding the other explanatory variables constant. Conversely, the coefficient of the logarithm of state GDP is positive. The model suggests that a 10% positive change to the state GDP results in a 0.0744 increase to the unemployment rate, when holding the other explanatory variables constant. The coefficient of the educational attainment variable is negative; this suggests that an increase of 1% to the percentage of the state population above the age of 18 that has at least a high school education results in approximately a 0.17 decrease to the unemployment rate. The coefficient of percentage of population in urban areas is negative, meaning a 1% increase to the percentage of the population living in an urban area results in a 0.005 decrease to the unemployment rate. Unlike many of the other explanatory variables used, the magnitude of this slope parameter is incredibly low and may suggests that the share of the population living in an urban area does not have a major impact on the unemployment rate. Lastly, the coefficient of the percentage change in per capita personal consumer expenditure is positive, which translates to a 1% increase to this value corresponding to a 0.064 increase to the unemployment rate.

Model 2 resulted in only the educational attainment data having statistical significance at the 1% significance level for a two-sided test. The p-value associated with this parameter is 0.002, which suggest a high level of statistical significance and shows that perhaps educational attainment is much more impactful factor when considering the unemployment rate. In extreme contrast to the original hypothesis of the study, the minimum wage variable shows no statistical significance at the typical 10%, 5%, or 1% significance levels for neither the one-sided nor two-sided test. In addition, none of the other slope parameters are statistically significant at the 10% significance level. These results implore the replacement of certain variables in the model and further analysis of significance which will later be carried out with an F-test.

<u>Model 3:</u>

The third model is a multiple linear regression model that dropped both the logarithm of state population and logarithm of state GDP. Instead, the logarithm of the per capita state GDP is used. This reduces the overall multicollinearity of the model since the logarithm of state population and logarithm of state GDP have a 0.97 correlation. Although the percentage change in the per capita personal consumer expenditure and state share of urban population showed no statistical significance in Model 2, they are retained in Model 3 as shown:

$$\textbf{Model 3: } \textit{unemploy} = \beta_0 + \beta_1(\textit{minWAGE}) + \beta_2(\textit{educ}) + \beta_3(\textit{urbpop}) + \beta_4(\textit{capPCE}) + \beta_5(\textit{logcapGDP}) + u$$

The 51 data points collected resulted in the OLS estimators used in the sample regression function:

$$\textbf{OLS Regression 3: } \textit{unemploy} = 6.177 + 0.099(\textit{minWAGE}) - 0.153(\textit{educ}) - 0.011(\textit{urbpop}) - 0.022(\textit{capPCE}) + 1.028(\textit{logcapGDP})$$

The R-squared value of this multiple regression model is 0.2282, which is very similar to Model 2. Therefore, the dropping and adding of variables used for Model 3 did not add nor sacrifice explanatory value to the study. The coefficient of the primary explanatory variable (minWAGE) increased in magnitude to 0.099 and increased in statistical significance with the p-value decreasing from 0.301 in Model 2 to 0.217 in Model 3. Although this still means it is not statistically significance at the 10%, 5%, or 1% levels, the decrease to the p-value offers reassurance that replacing the logarithm of state population and logarithm of state GDP with the logarithm of per capita GDP improved the model.

Worthy of note is that the slope parameter for the percentage change in per capita personal consumer expenditure changed from a positive to a negative value while simultaneously decreasing its statistical significance; the p-value changed from 0.75 to 0.903. In either case, the per capita personal consumer expenditure (and, therefore, inflation) does not have a major impact on the unemployment rate, at least in the short run. The statistical significance of the educational attainment was left mostly unchanged with a relatively minute increase p-value. The coefficient of the percentage of state population in urban areas drastically increased in both magnitude and statistical significance. The newly generated slope parameter suggests that a 1% increase to the urban population results in a 0.011 decrease to the unemployment rate, which is an impact over double that of its Model 2 counterpart. The p-value of the urban population also decreased from 0.64 to 0.265. Lastly, the new explanatory variable of Model 3 (logarithm of per capita state GDP) has a high magnitude positive coefficient that is significant at the 10% level for a two-sided test. This, once again, offers reassurance that using the logarithm of per capita state GDP instead of the two dropped variables improves the model. The coefficient suggests that a 1% positive change to the per capita state GDP results in a 0.01 increase to the unemployment rate, which is inconsistent with the predicted negative effect of per capita GDP on the unemployment rate.

<u>Model 4:</u>

The fourth model is once again a multiple linear regression model that includes only the primary explanatory variable of minimum wage and the two statistically significant additional explanatory variables (educational attainment and the logarithm of per capita state GDP). In doing so, the percentage of the state population in urban areas as well as the percentage change in the per capita personal consumer expenditure were dropped resulting in the model depicted below:

Model 4: $unemploy = \beta_0 + \beta_1(minWAGE) + \beta_2(educ) + \beta_3(logcapGDP) + u$

The 51 data points collected resulted in the OLS estimators used in the sample regression function:

OLS Regression 4: $unemploy = 6.177 + 0.082(minWAGE) - 0.13(educ) + 0.669(logcapGDP)$

The R-squared value for this model is 0.2032, which is a major decrease compared to both Model 3 and Model 2. The slope parameter of minimum wage has decreased in both magnitude and statistical significance. In addition, the logarithm of per capita state GDP is no longer statistically significant at the 10% level the educational attainment slope parameter similarly experiences a large decrease in statistical significance, although it is still significant at the 1% level. Given these results, Model 3 is a better-quality model of the data and its impact on unemployment.

The four models and their respective coefficients and correlations are summarized in Table 3. The one, two and three asterisks correspond to statistical significance at the 10%, 5%, and 1% significance values when performing a two-sided t-test, respectively.

Dependent Variable: *unemploy*				
Independent Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
minWAGE	0.097* (0.066)	0.086 (0.082)	0.099 (0.079)	0.082 (0.073)
logpop	--	-0.92 (0.646)	--	--
logstGDP	--	0.744 (0.65)	--	--

educ	--	-0.172*** (0.052)	-0.153*** (0.048)	-0.13*** (0.043)
urbpop	--	-0.005 (0.11)	-0.011 (0.01)	--
capPCE	--	0.064 (0.199)	-0.022 (0.181)	--
logcapGDP	--	--	1.028* (0.611)	0.669 (0.519)
Intercept	2.776*** (0.593)	15.625*** (4.572)	6.177 (6.086)	7.25 (5.797)
Observations	51	51	51	51
R-squared	0.0424	0.2347	0.2282	0.2032

V. Extensions

After creating the first set of models, it becomes apparent that Model 3 offers the most balanced and statistically significant form of the analysis. As such, extensions of the model including robustness tests and truncation of the data are applied using the Model 3 functional form. As previously discussed, the heavy concentration of minimum wage data points at the value of $7.25 drastically decrease the variability of the primary independent variable, leading to a less reliable slope parameter. To account for said lack of variability, Model 5 inherits the same functional form as Model 3, except only data points corresponding to minimum wages above $7.25. In doing so, the total amount of observations used for the model shown below decreased to 30:

Model 5: $unemploy = \beta_0 + \beta_1(minWAGE) + \beta_2(educ) + \beta_3(urbpop)$
$+ \beta_4(capPCE) + \beta_5(logcapGDP) + u$

OLS Regression 5: $unemploy = -4.402 – 0.16(minWAGE) - 0.15(educ) – 0.017(urbpop)$
$+ 0.007(capPCE) + 2.25(logcapGDP)$

The R-squared value of this truncated model is 0.2894, which is significantly higher than the previous 4 models. The minimum wage value is still not statistically significant, however, the logarithm of the per capita state GDP increased in statistical significance and is nearly significant at the 1% level having a p-value of 0.012.

The percent change in per capita personal consumer expenditure is the least statistically significant explanatory variables. Additionally, since minimum wage and the share of urban population of the state are both still statistically insignificant at all major levels, an F-test was run combining minimum wage with the other two insignificant explanatory variables. The F-test were run using the truncated data set used to produce Model 5 (the unrestricted model). The null and alternate hypotheses for said test are shown below:

$$H_0: \beta_1=0, \beta_3=0, \beta_4=0$$

$$H_1: H_0 \text{ is not true}$$

In these hypotheses, β_1, β_3, and β_4 represent the coefficients of the minimum wage, state share of urban population, and percent change in per capita personal consumer expenditure, respectively. The F-value calculated was 0.817, which is less than the critical value for 3 numerator degrees of freedom and 24 denominator degrees of freedom of 2.33 (for the 10% level). Therefore, there is not enough evidence to reject the null hypothesis and the study concludes that the three explanatory variables are not jointly significant.

The second F-test is like the first, however, the original dataset with 51 observations is used rather than the truncated dataset. Therefore, the null and alternate hypotheses are the same, but the F-value will differ. The F-value was calculated to be 0.898, which is still lower than the corresponding 10% level critical value for 3 numerator degrees of freedom and 45 denominator degrees of freedom, which is 2.23. It is also worth noting that a third F-test was carried out that was essentially the same as the second, except the percent change in per capital personal consumer expenditure was not restricted, however, its extremely low statistically significance had essentially no effect on the conclusions from the F-test. This stems from the fact that due to the per capita personal consumer expenditure's extremely high statistical insignificance, restricting it from the model does not lead to a high magnitude change in the R-squared value associated with the model, leading to a smaller F-value for comparison with the critical value.

From the initial scatter plot shown earlier in the study, there does not seem to be a more fitting functional form of the relationship between the unemployment rate and the minimum wage. In fact, once the concentration of data points at a minimum wage of $7.25 are removed from the observation pool, the relationship depicts a moderate negative correlation (assuming a linear relationship). To confirm this suspicion, a simple linear regression model was run to regress the unemployment rate on the minimum wage using the truncated data set of only 30 observations. The results are summarized below:

Model 6: $unemploy = \beta_0 + \beta_1(minWAGE) + u$

OLS Regression 6: $unemploy = 3.382 + 0.039(minWAGE)$

The regression produced has an even lower magnitude coefficient on minimum wage than the original simple regression model, showing that after increasing the variability in the primary independent variable by truncating the data, the impact of the minimum wage on the unemployment is even less (and this effect has a higher statistical significance than did the original simple linear regression). The R-squared value is

0.0048 and the 95% confidence interval for the coefficient of minimum wage is -0.18 to 0.26. Both these metrics further emphasize that the minimum wage does not have a major impact on the unemployment rate.

The two additional models presented when extending the study are summarized in the table below. The major difference was using a different number of observations to generate the OLS regressions. Similar to the first summarizing table, one, two, and three asterisks correspond to statistical significance of the associated parameter at the 10%, 5%, and 1% levels with respect to a two-sided t-test.

Dependent Variable: *unemploy*		
Independent Variables	**Model 5**	**Model 6**
minWAGE	-0.16* (0.14)	0.039 (0.11)
educ	-0.15** (0.07)	--
urbpop	-0.017 (0.12)	--
capPCE	0.007 (0.22)	--
logcapGDP	2.25** (0.83)	--
Intercept	-4.402 (8.17)	3.382*** (1.08)
Observations	30	30
R-squared	0.2894	0.0048

VI. Conclusions

This study sought to uncover if there is a significant impact of the minimum wage on the unemployment rate in the United States. In agreement with classical microeconomic theory, the hypothesis was that the minimum wage would have a positive relationship with the unemployment rate, meaning as the minimum wage would increase, so would the unemployment rate. The simple linear regression run showed no such relationship, and the multiple linear regressions that controlled for other explanatory variables only revealed mild statistical significance, most of which were at the 10% level. In addition to the alternative regression run, the extended portion of the study utilized a truncated form the dataset to increase variability in the primary explanatory variable to produce more reliable slope parameters associated with minimum wage. In the circumstance of the truncated dataset, there was still no statistically significant impact found for minimum wage on unemployment. As such, the study concludes that the data and regression overwhelmingly do not support the hypothesis. However, the data does not necessarily support the converse statement that minimum wage increases decrease the unemployment rate. Through analysis of p-values, confidence intervals, and F-tests for joint significance, it is simply concluded that there is not enough evidence in most cases to conclude that the minimum wage has any discernible effect on unemployment.

Though the primary explanatory variable did not prevail as a statistically significant indicator of unemployment, two of the additional controlled explanatory variables emerged as major indicators. The first was the educational attainment percentage of a state's population (the percentage of the population above 18 with at least a high school education or equivalent). In nearly all the regressions generated, the coefficient associated with educational attainment was statistically significant at the 1% level (except for Model 5, in which case it was only significant at the 5% level). The effect of educational attainment on the unemployment rate was consistent with the original prediction made in the study and suggests that the more educated a population is, the more valuable their human capital becomes, leading to less unemployment.

The second controlled explanatory variable that was statistically significant was the per capita state GDP. This factor encompassed an arithmetic relation between population growth and GDP growth for a state and showed that higher state productivity per person indicates low levels of unemployment. This suggestion is similarly consistent with the original prediction made in the study.

As for economic implications of the findings of this cross-sectional study, it becomes apparent that minimum wage may not necessarily be an effective tool to control or effect the unemployment rate. Rather, investment in educating a public to increase the value of the human capital produced and urbanization for population and industry growth may prove more effective remedies for unemployment. Of course, the study does not claim causality between the two statistically significant explanatory variables and the unemployment rate, but that as effective indicators, it is these areas of society that help determine the health of the workforce and well-being of a state's populace through their proven statistical relationships.

Appendix A. List of States and Municipality used in data collection (Note: Asterisk signifies that 2019 was the year of a minimum wage increase in the state)

Alabama	Illinois	Montana*	Rhode Island*
Alaska*	Indiana	Nebraska	South Carolina
Arizona*	Iowa	Nevada	South Dakota*
Arkansas*	Kansas	New Hampshire	Tennessee
California*	Kentucky	New Jersey*	Texas
Colorado*	Louisiana	New Mexico	Utah
Connecticut	Maine*	New York*	Vermont*
Delaware*	Maryland	North Carolina	Virginia
District of Columbia*	Massachusetts*	North Dakota	Washington*
Florida*	Michigan*	Ohio*	West Virginia
Georgia	Minnesota*	Oklahoma	Wisconsin
Hawaii	Mississippi	Oregon*	Wyoming
Idaho	Missouri*	Pennsylvania	

Appendix B. Correlation coefficients between all variables used to satisfy Gauss-Markov assumption 3

	unemploy	*minWAGE*	*logpop*	*logstGDP*	*educ*	*urbpop*	*logcapGDP*	*capPCE*
unemploy	1.00							
minWAGE	0.21	1.00						
logpop	0.02	-0.05	1.00					
logstGDP	0.06	0.09	0.97	1.00				
educ	-0.32	0.20	-0.52	-0.45	1.00			
urbpop	0.12	0.38	0.42	0.55	-0.17	1.00		
logcapGDP	0.18	0.55	-0.10	0.14	0.29	0.53	1.00	
capPCE	0.10	0.37	0.44	0.48	-0.12	0.37	0.17	1.00

Appendix C. STATA Regression Model Outputs

Model 1:

```
. regress unemploy minWAGE
```

Source	SS	df	MS			
				Number of obs	=	51
				F(1, 49)	=	2.17
Model	1.4329745	1	1.4329745	Prob > F	=	0.1470
Residual	32.3333006	49	.659863278	R-squared	=	0.0424
				Adj R-squared	=	0.0229
Total	33.7662751	50	.675325502	Root MSE	=	.81232

unemploy	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
minWAGE	.096672	.0656007	1.47	0.147	-.0351575	.2285015
_cons	2.765851	.5917178	4.67	0.000	1.57675	3.954952

Model 2:

```
. regress unemploy minWAGE logpop logstGDP educ urbpop capPCE
```

Source	SS	df	MS			
				Number of obs	=	51
				F(6, 44)	=	2.25
Model	7.92368375	6	1.32061396	Prob > F	=	0.0560
Residual	25.8425914	44	.587331622	R-squared	=	0.2347
				Adj R-squared	=	0.1303
Total	33.7662751	50	.675325502	Root MSE	=	.76638

unemploy	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
minWAGE	.0861186	.0822254	1.05	0.301	-.0795958	.251833
logpop	-.9197388	.6457976	-1.42	0.161	-2.221258	.3817807
logstGDP	.7441634	.6504105	1.14	0.259	-.5666529	2.05498
educ	-.1715644	.0520769	-3.29	0.002	-.2765184	-.0666103
urbpop	-.0050894	.0108149	-0.47	0.640	-.0268853	.0167066
capPCE	.0637442	.1987559	0.32	0.750	-.336822	.4643105
_cons	15.62542	4.572111	3.42	0.001	6.410938	24.83991

Model 3:

```
. regress unemploy minWAGE educ urbpop capPCE logcapGDP
```

Source	SS	df	MS
Model	7.704368	5	1.5408736
Residual	26.0619071	45	.579153491
Total	33.7662751	50	.675325502

Number of obs	=	51
F(5, 45)	=	2.66
Prob > F	=	0.0344
R-squared	=	0.2282
Adj R-squared	=	0.1424
Root MSE	=	.76102

unemploy	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
minWAGE	.0985506	.078634	1.25	0.217	-.0598263	.2569275
educ	-.153207	.0475184	-3.22	0.002	-.248914	-.0574999
urbpop	-.0109577	.009705	-1.13	0.265	-.0305046	.0085892
capPCE	-.0222845	.1810699	-0.12	0.903	-.386978	.3424089
logcapGDP	1.027937	.6111405	1.68	0.099	-.2029629	2.258837
_cons	6.176556	6.086272	1.01	0.316	-6.081825	18.43494

Model 4:

```
. regress unemploy minWAGE educ logcapGDP
```

Source	SS	df	MS
Model	6.86120328	3	2.28706776
Residual	26.9050718	47	.572448337
Total	33.7662751	50	.675325502

Number of obs	=	51
F(3, 47)	=	4.00
Prob > F	=	0.0129
R-squared	=	0.2032
Adj R-squared	=	0.1523
Root MSE	=	.7566

unemploy	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
minWAGE	.0816714	.0729821	1.12	0.269	-.0651497	.2284925
educ	-.1297301	.0430323	-3.01	0.004	-.2162999	-.0431604
logcapGDP	.6692835	.5194755	1.29	0.204	-.3757664	1.714333
_cons	7.249949	5.797488	1.25	0.217	-4.413093	18.91299

Model 5:

```
. regress unemploy minWAGE2 educ urbpop capPCE logcapGDP
```

Source	SS	df	MS
Model	5.75343264	5	1.15068653
Residual	14.1252336	24	.588551399
Total	19.8786662	29	.685471249

Number of obs	=	30
F(5, 24)	=	1.96
Prob > F	=	0.1222
R-squared	=	0.2894
Adj R-squared	=	0.1414
Root MSE	=	.76717

unemploy	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
minWAGE2	-.1598846	.1422422	-1.12	0.272	-.4534581	.1336888
educ	-.1504925	.0704638	-2.14	0.043	-.2959227	-.0050623
urbpop	-.0171849	.0123221	-1.39	0.176	-.0426165	.0082467
capPCE	.0072302	.2187626	0.03	0.974	-.4442737	.4587341
logcapGDP	2.24949	.8322711	2.70	0.012	.5317668	3.967213
_cons	-4.40175	8.172222	-0.54	0.595	-21.26839	12.46489

Model 6:

```
. regress unemploy minWAGE2
```

Source	SS	df	MS
Model	.095279952	1	.095279952
Residual	19.7833863	28	.706549509
Total	19.8786662	29	.685471249

Number of obs	=	30
F(1, 28)	=	0.13
Prob > F	=	0.7162
R-squared	=	0.0048
Adj R-squared	=	-0.0308
Root MSE	=	.84056

unemploy	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
minWAGE2	.0392842	.1069765	0.37	0.716	-.1798473	.2584157
_cons	3.381552	1.077858	3.14	0.004	1.173659	5.589444

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